

CLAIMS:

What is claimed is:

5 1. A process for bleaching a lignin-containing material, comprising treating the material with an oxidative enzyme, a pro-oxidant, and a pro-degradant.

2. The process of claim 1 wherein said oxidative enzyme is a laccase, a catechol oxidase, a monophenol monooxygenase, a bilirubin oxidase, or a mixture thereof.

10 3. The process of claim 1 further comprising adding a hydrolase.

4. The process of claim 3 wherein said hydrolase is xylanase.

15 5. The process of claim 1 further comprising adding an oxidizing agent.

6. The process of claim 5 where said oxidizing agent is at least one of air, oxygen, and hydrogen peroxide.

20 7. The process of claim 1 wherein said pro-oxidant is ascorbic acid, ascorbate, salicylic acid, salicylate, nicotinic acid, nicotinate, a hardwood black liquor, a softwood black liquor, ligno-organosolv, lignin sulfonate, or a mixture thereof.

25 8. The process of claim 1 where said pro-degradant is urea, thiourea, sulfamic acid, sulfamide, guanidine, methylsulfonic acid, or a mixture thereof.

9. The process of claim 1 wherein said material is a wood pulp.

10. The process of claim 9 wherein said wood pulp is a raw material used to form a cellulose or a cellulose derivative.

5 11. A process for oxidizing a substrate, wherein said process comprises treating the substrate with an oxidizing enzyme, a pro-oxidant, and a pro-degradant.

12. The process of claim 11 wherein said oxidizing enzyme is a laccase, a catechol oxidase, a monophenol monooxygenase, a bilirubin oxidase, or a mixture thereof.

10 13. The process of claim 11 that further comprises adding an oxidizing agent.

14. The process of claim 13 wherein said oxidizing agent is at least one of air, oxygen, and hydrogen peroxide.

15 15. The process of claim 11 wherein said pro-oxidant is ascorbic, ascorbate, salicylic acid, salicylate, nicotinic acid, nicotinate, a hardwood black liquor, a softwood black liquor, ligno-organosolv, lignin sulfonate, or a mixture thereof.

20 16. The process of claim 11 wherein said pro-degradant is urea, thiourea, sulfamic acid, sulfamide, guanidine, methylsulfonic acid, or a mixture thereof.

17. The process of claim 11 that further comprises adding an oxidizing agent.

25 18. The process of claim 17 wherein said oxidizing agent is at least one of air, oxygen, and hydrogen peroxide.

19. A composition comprising an oxidative enzyme, a pro-oxidant, and a pro-degradant.

20. The composition of claim 19, wherein said oxidative enzyme is a laccase, a catechol oxidase, a monophenol monooxygenase, a bilirubin oxidase, or a mixture thereof.

21. The composition of claim 19 that further comprises a hydrolase.

22. The composition of claim 21 wherein said hydrolase is xylanase.

23. The composition of claim 19 wherein said pro-oxidant is ascorbic acid, ascorbate, salicylic acid, salicylate, nicotinic acid, nicotinate, a hardwood black liquor, a softwood black liquor, ligno-organosolv, lignin sulfonate, or a mixture thereof.

24. The composition of claim 19 wherein said pro-degradant is urea, thiourea, sulfamic acid, sulfamide, guanidine, methylsulfonic acid, or a mixture thereof.

25. A two-component mediator for use in a laccase-mediator system, said two-component mediator comprising (i) a pro-oxidant and (ii) a pro-degradant.

26. The mediator of claim 25 wherein:

(i) said pro-oxidant is ascorbic acid, ascorbate, salicylic acid, salicylate, nicotinic acid, nicotinate, a hardwood black liquor, a softwood black liquor, ligno-organosolv, lignin sulfonate, or a mixture thereof; and

(ii) said pro-degradant is urea, thiourea, sulfamic acid, sulfamide, guanidine, methylsulfonic acid, or a mixture thereof.